that the spot on which the celt was found should be within thirty yards of the site of a Roman building discovered by me in 1864.

Gurnet Bay, April 9 E. J. A'COURT SMITH

Arctic Temperatures

IN your article on the Austrian Polar Expedition (vol. xi. p. 397), it is stated that in January "the warm S. and S.W. winds always brought great masses of snow, and produced a rise in the temperature amounting to 30°–35° R. in a few hours." 32 R. = 72 F.

Such enormous fluctuations of temperature are unparalleled in any other part of the world, and it seems quite impossible that they can be due to any drift of warm air. I would suggest that they are probably caused by the wind tearing up the frozen surface of the sea, and liberating the heat of the unfrozen water below. Dr. Kane, when wintering in Smith Sound, once met with such a rise of temperature, and he says that open water was near. This explanation of the phenomenon is supported by the fact you mention in the same article, page 398, that in the summer the temperature was remarkably constant. The same cause could not act during summer, for the air is not then much colder than the unfrozen water.

There is no doubt of the power of a storm of wind to tear up a very thick sheet of ice. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, March 30

AËRONAUTICS

M. GASTON TISSANDIER has just finished the analysis of carbonic acid contained in the air collected during his recent ascent (vol. xi. p. 429). He found at Paris 37 cubic centimetres per 100,000 ; at a height of 2,700 feet, 27 ; and at a level of 3,300 feet, 30. The difference of altitude between the two aërial stations being too small to justify drawing any conclusions he will shortly make another ascent with the same balloon to an altitude of 24,000 feet.

M. Godard made an ascent in the balloon *Saturn*, from Bayonne, on March 29, at half-past five, and was drifted over the Pyrenees. The trip was difficult, as the balloon was loaded with snow and hail, and all the ballast was thrown over in order to keep the balloon afloat. The cold was intense, and the wind very strong. The landing took place at Azul Mayor, a small country town east of Pampeluna, at half-past seven, the distance run being 120 kilometres. The grapnel having been broken, the aëronaut and the three passengers were severely hurt. This is the first time that any balloon has crossed the Pyrenees. The *Saturn* followed the French valley of the Nive and the Spanish valley of Baztan on the southern side. An interesting observation was made when crossing the culminating point of the pass. The Larratéce Neguya was surrounded by cirro-cumulus, which resisted the force of the wind and seemed an obstruction in the way of aëronauts, who found it necessary to throw out a certain quantity of ballast, and to reach an altitude of 6,600 feet, in order to cross that sea of motionless clouds. A strong hissing noise was heard when travelling over them ; whether it was produced by the friction of the air on the peaks or on the masses of electrified vapours, can only be decided by another experiment conducted scientifically.

On April 4 two ascents were made almost simultaneously. M. Triquet ascended from the Place du Trône, Paris, and landed at Montreuil, 20 kilometers from his starting-point, forty minutes afterwards, having run in an E.S.E. direction. M. Duruof ascended from Cahors, in the Lot, and landed at Catres, in the same department, having run 22 kilometers in sixty-five minutes, but in a N.N.W. direction. Both balloons having ascended at the same moment, moved at right angles.

I have reason to believe that a number of ascents will be made simultaneously from La Villette gasworks, and the several tracks compared with each other. Some interesting facts may be elicited by these comparative trips. W. DE FONVIELLE

ARCTIC GEOLOGY *

II.

Cryolite of West Greenland Coast.—At Evigtok (*ivik*, Eng. grass), twelve miles from Arksut (Eng. leeward), in 61° 13′ lat. and 48° 9′ W. long., the mountains rise to a height of more than 2,000 feet, enclosing a sort of basin, with an area of more than a square mile, the bottom of which is covered with grass and *Salix arctica*, four feet in height, and other plants. This is much frequented in summer by the Greenlanders, who catch large numbers of capelins and cod, which frequent the coast in shoals, as well as the *Salmo arcturus*, Linn. (the *Loddé* of the Norwegians). Weights used in this fishery, taken by Danish missionaries to Copenhagen at the beginning of the century, were found to be composed of cryolite, which led to the discovery of two veins of that mineral in the gneiss at the head of the bay, which has since been worked by Mr. Tayler, F.G.S. The white cryolite bed is about eighty feet in width, dipping south with the planes of the gneiss in which it occurs. Near its higher portion there is a large quantity of galena, worked in 1854, which gave 82½ per cent. of argentiferous lead, containing forty-five ounces of silver to the ton of ore. Fifteen feet from the surface the cryolite was of a dark colour, so that it is probable that the black cryolite in the higher vein is merely less decomposed, and not bleached. The Greenlanders value the white variety most, which they call orksoksiksæt (*orsok*, blubber), from its soft greasy appearance and feel ; they gradually pound tobacco leaves placed between two pieces of it, the resultant powder consisting of half of cryolite dust, which they consider superior to any European snuff.†

Large quantities of cryolite are now imported to Copenhagen, the mines being worked by Messrs. Thomsen, of that city. Mr. Qualye reports that pieces of gneiss and trap are found imbedded in the cryolite, and states that the mines are filled with snow and ice during the winter, work being carried on by fifty men from May to October ; 5,000 tons are raised yearly. Cryolite, except at Miask, in Siberia, does not occur out of Greenland.

Cryolite is a fluoride of sodium and aluminium, and is composed, according to Mr. Evan T. Ellis, of—

13 per cent. of aluminium,
34 „ „ sodium,
53 „ „ fluorine.

In Denmark, it is largely used in the manufacture of soda, which is procured by mixing it with lime and applying heat, 100 tons of cryolite yielding forty-four of caustic soda. It was introduced into Philadelphia by the Pennsylvania Salt Company, who imported 8,000 tons in 1867. By mixture with silica a very beautiful glass is produced, capable of being moulded. Cryolite was used by Deville as a flux in the manufacture of aluminium, the process of extracting aluminium from it was first used by Mr. Dick in 1856, but its use has since been abandoned in favour of bauxite. The fluoride of calcium is sent to Paris to be used in glass etching.

Associated with the Greenland cryolite brought over

* Continued from p. 449.

† Giesecke, *Edin. Phil. Jour.* vol. vi. 1822 ; J. W. Tayler, *Quar. Jour. Geol. Soc.*, 1856 ; *Chemical News*, 1868, p. 8, &c. ; *Proceedings Amer. Pharm. Soc.*, 1868 See Rink's Memoir on Greenland, published by the Royal Danish Academy of Sciences, 1853, p. 71 ; L. Jacobsen's "Et Aar i Grönland, 1862" ; and Lieut. Bluhme, in the Danish magazine *Fra alle Lande*, vol. i.

by Mr. Tayler, M. Hagemann found, in 1868, Pachnolite and Columbite, and a mineral he termed Arksutite. Near the cryolite deposits also occur extensive veins of tinstone, covering an area 1,500 feet long by 80 feet broad, running E. and W. and N.E. and S.W., with a width of 10 inches, the tin being 1 inch to 1¼, and the gangue felspar or quartz, associated with galena, spathic carbonate of iron, copper and iron pyrites, tantalite taking the place of wolfram, usually associated with tin ores.

*Mid-Greenland.**—Sigillaria and a fern, probably *Pecopteris*, were discovered by Dr. Pfaff in 1870-71, in erratic blocks, on the coast of Disco; they appear to have been derived from rocks of Carboniferous age, but as none such are now in Greenland, it is most probable, as has been suggested, that they were brought by floating ice from Melville Island.

The Greenland coast and islets are composed of gneiss from 68° 30′ to 71° N. lat., with the exception of the projecting peninsula of Noursoak, the north-eastern coast of which, in Omenak Fjord, consists of Cretaceous rocks, in which, however, no calcareous beds have as yet been discovered, and from which the only fossils obtained have been several species of plants, determined by Prof. Heer, including *Pecopteris arctica*, Hr., *P. borealis*, Brong., and eight other ferns, *Zamites arcticus*, Göpp., *Sequoia Reichenbachii*, Gein., *Pinus Peterseni*, and a Monocotyledon, *Fasciculites Grœnlandicus*, Hr.

The western coast of Noursoak consists of trap, as does also that of the island of Disco, or Kekertassuak, as far as Lievly or Godhavn, where there is a patch of syenite. The shores of the Waigat Strait, both on the Noursoak and Disco Island side, consist of Miocene beds, which also extend in Disco along the east coast to Godhavn, and are more or less associated with the trap (basalt), which consists entirely, according to Nordenskjöld, of "consolidated beds of ashes and volcanic sand," which by pressure have assumed a crystalline form.

The Cretaceous strata of the north coast of Disco are divided by Nordenskjöld into two series, the lower, or *Kome strata*, and the higher, or *Atane beds*. The former consist of a sedimentary coal-bearing formation filling up old valleys and depressions in the undulating gneiss beds, reaching a thickness of 1,000 feet, lying either horizontally or dipping 20° towards the Noursoak peninsula. It is probable that the plant remains brought home by Giesecke and Rink were from this series, beds at the base associated with the lowest thin coals being so full of leaves as to have become a felted flexible mass, resembling the vegetable parchment produced by the action of sulphuric acid on lignite. Coal is collected by the Greenlanders for their personal household use at Kome, Sarfarfik, Pattorfik, and Avkrusak. Amongst the plants from Kome are the beautiful Cycads *Zamites arcticus*, *Glossozamites Heheneggeri*, and several plants stated by Heer to occur in the Urgonian strata of Wernsdorff.

On the gneiss of Karsok River, at 840 feet above the sea, occur sedimentary strata, basalt, and gravel, which continue to 1,150 feet up the slope, where a gravel with angular pieces of graphite occurs, near a sandstone with coal; the graphite is stated by Capt. Brockdorff, who took five tons to Europe in 1850, to form a horizontal bed eight to ten inches thick, covered with clay, sand, and sandstone. As the beds lie horizontal, and are 300 feet above the Cretaceous rocks, the graphite must be of Cretaceous or still more recent age. Graphite also occurs at Niakornet. An analysis of the Karsok graphite, by Dr. Nordström, gave carbon 95·68, hydrogen 0·22, and ash 3·60; the latter gave 50 per cent. of silica.

Graphite also occurs further north, at Uppernivik, near Sanderson's Hope, in fine-grained granite, consisting of grey quartz and felspar of a waxy lustre, with garnets one inch in diameter.

* The Danish Government divides the coast into a North and South Inspectorate, the former commencing at lat. 66°, and extending to 73° N. beyond which they do not maintain a monopoly of the trade.

The Atane strata occur on the southern side of the Noursoak peninsula, between Atanekerdluk and Atane (Nordenskjöld); the thick coal of Atane, that at 750 feet above the sea at Kome, the Ritenbenk coal-mine at Kudliset, the retinite beds of Hare Island, all probably belong to this portion of the series. Dicotyledonous leaves occur, one being near to *Magnolia alternans*, Heer, from Upper Cretaceous of Nebraska; these do not occur in the lower measures, and point to a "limit plant fauna" occurring in the Arctic Cretaceous beds, corresponding to that found in the European Gault, in which dicotyledonous plants first appear in Europe.

Two analyses have been made of the coals from Disco, but whether of Cretaceous or Miocene age I do not know; one by Prof. Fyfe,* of Aberdeen, the other by Mr. Keates, of London† :—

		Keates.	Fyfe.
Sp. gravity		1·369	1·384
Gaseous or vol. matter ...		44·45	50·60
Moisture		·75	—
Sulphur		·55	—
Coke	Fixed carbon ...	47·75	37·86
	Ash	5·50	9·54
		100·00	100·00

The lignite contains a trace of bitumen, but the coke is non-caking and useless.

Miocene Rocks.—Sir Charles Giesecke, F.R.S., describing Disco Island in 1821,‡ gives the following section of Ounartosak Mountain, near Godhavn :—

1. Basalt, columns with three to seven sides, more or less magnetic.
2. Reddish-brown ferruginous clay.
3. Amorphous basalt, with geodes of mesotite, &c.
4. Reddish-brown ferruginous clay.
5. Reddish-brown wacke, with stilbite, mesotite, &c.
6. Trap Tuff.

6*a*. Basalt Tuff, with geodes of crystallised apophyllite with mesotite or earthy zeolite.

7. Granite, with garnets.

The trap (basalt) rocks lie tolerably flat, and range S.W. to N.E., resting on gneiss. Sandstones occur at Aukpadlartok, and thence to Aumarurtiksæt, where coal seams occur, one of which is 9 feet in thickness, the section being :—1. Sandstone with pyrites; 2. Brown coal; 3. Schistose sandstone; 4. Pitch coal; 5. Argillaceous schist; 6. Brown coal; 7. Sandstone with plants.

From the granite (gneiss?) of the islands on the south side of Disco, Giesecke records tinstone, magnetic pyrites, epidote, and diallage, and states that the Disco mesotite was found by Sir David Brewster to vary much from that of Auvergne; and he describes the occurrence of rounded boulders of primitive rocks at the tops of the highest mountains near the coast. Giesecke's collections were destroyed in the bombardment of Copenhagen, whilst he went to Greenland in the Danish service, and the collections he made in that country were captured by English cruisers and sold by auction at Leith, where they were purchased by Mr. Allan, who distributed the duplicate specimens of Greenland cryolite, sodalite, and allanite, at that time of great rarity, over Britain.

At Atanekerdluk, Nordenskjöld describes Miocene clays with vast numbers of plant impressions, at 1,000 to 1,200 feet above the sea, and newer than the Atane beds, the base of the Miocene beneath the clay being soft sandstone and sand; the strike of the strata corresponds to that of the strait, and the dip is 8—32° to E.N.E. It formerly extended across the strait, and forms sandhills 2,000 to 3,000 feet in height along the eastern shore of Disco, horizontal thin coal-bands and erect bitumenised trees occasionally occurring. No valuable coals, however, are worked in the Lower Miocene, which is separated from

* Appendix to Inglefield's "Summer Search after Sir John Franklin," p. 151.

† Phil. Trans. for 1869, p. 449.

‡ Trans. Royal Soc. Edin., 1821.

the coal-bearing Middle Miocene of Ifsorisok and Assakak by several thousand feet of basalts, but the flora is similar to that of the lower fossiliferous beds. The coals of the high fells of Skandsen and Assakak are also believed to belong to this horizon.

At the creek at Atanekerdluk the general strike of the beds is E.N.E., clay, ironstone, or siderite (Atanekerdluk-stour of Greenland Danes), with impressions of plants, being of frequent occurrence. Trap (basalt) dykes traverse the strata in regular lines running obliquely, and often stand out like obelisks, one of which is 80 feet in height. On the slopes occurred erratic blocks of grey syenite, &c.

It is probable that Greenland Miocene basalt extends, as suggested by Nordenskjöld, across the country north of the sixty-ninth degree of latitude, as Scoresby found impressions of plants in what he termed "trap" along the whole coast of East Greenland examined by him. The second German expedition has also brought back large collections, and it is possible that these deposits may extend under the sea to Iceland, Jan Mayen, and Spitzbergen, At Brännvinshamn, Skarffjäll, Kudliset, magnificent examples of columnar basalt occur comparable to Staffa and other European localities. At Godhavn, the lowest bed resting on the gneiss, is a basaltic tuff, with several species of zeolites, then columnar basalt, then tuff with zeolites, alternating with that basalt. At Atanekerdluk, near the shore, is a high mountain composed of crystalline dolerite similar to the Spitzbergen hyperite, and along the coast basaltic beds fifty to 100 feet thick, traversed by basaltic dykes, may be traced for miles.

On the east coast of Disco, sand and sandstone beds form mountains 1,500 to 2.000 feet, capped by basalt; in Waigat Straits these sink, and the basalt reaches the shore, but at a height of 1,000 feet, sand, clay, and coal occur.

These Miocene coals and plant-beds spread over an extensive area, for Sir John Richardson describes their occurrence on the banks of the Mackenzie, associated with gravels, sandstones, and potter's clay with plant remains, which he figured; while to the east, in Spitzbergen, a large number of species are in common, and many species also occur on the coast of the Baltic, in Switzerland, France, Italy, and Greece, four Greenland species including *Sequoia Couttsiæ*, so common at Bovey Tracey in Devonshire. Out of 321 species of Miocene Arctic plants now known, 167 were found in Greenland.*

East Greenland.—The second German expedition is stated to have discovered† coals of Liassic age on this coast, and a large number of Miocene plants, some of which had previously been found by Scoresby in 1822.

Both the Cretaceous and Miocene rocks of Greenland appear to have been deposited in fresh water, around which grew leafy trees, including nine species of oak, of which two were evergreen, like the Italian oak; two beeches, two planes, a walnut, hazel, sumach, buckthorn, holly, and Guelder rose, proving the climate to have been a temperate and not a tropical one.

Prof. H. E. Nordenskjöld‡ found the Greenland meteorites to be spread over an area of 200 square miles at the south-western corner of Disco Island, as Ovifak or Blue Hill, both in the region of greenstone basalt, and in that occupied by granite-gneiss; the fall he believes to have taken place in Miocene times, and he describes Widmannstætten's figures as best developed in the specimens where nickeliferous wrought is mixed with nickeliferous cast iron.

The basalt he found to be consolidated basaltic ashes, and to contain fragments of the meteorites which have been forced or fallen into cracks before the tuff was consolidated. The largest block noticed probably weighed 21,000 kilogrammes, that now in the British Museum weighing about eighty-seven.

In the British Museum is an Esquimaux knife, with a bone handle, the blade composed of small pieces of meteoric iron, presented by Sir Edward Sabine, who described it in 1819 (Quar. Jour. of Science, vol. vii. p. 79), and stated that the iron was procured by the Greenlanders from a hard dark rock in a hill in 76° 10′ lat., and 64° 75′ long.; they called the place *Sowilie*, from *sowie*, iron. Similar implements have been more recently described by Steenstrup, at the Anthropological Congress at Brussels, in 1872, and figured in *Matériaux pour l'histoire primitive de l'Homme*, 2 série, t. iv. 1873. In the third voyage of Capt. Cook, it is stated that the inhabitants of Norton Sound, Behring's Straits, call the iron they obtain from the Russians *shawie*.

M. Daubrée * describes three distinct types of the so-called meteorites from the basalt of Ovifak, discovered by Prof. Nordenskjöld: (1), a black metallic mass, which, polished, shows a network of white lamellæ (like schreiberite), and irregularly scattered grains (troilite); (2), a light grey metallic mass resembling ordinary iron; and (3), a dark green lithoid mass of silicates, with globules and grains of iron, the silica reaching in one instance 11·9 per cent. of the total weight.

	First Type.		Second Type.		Third Type.	
Iron, metallic	40·94	71·09	80·8	82·4	61·99	70·1
„ combined	30·15		1·6		8·11	
Carbon, combined	3·00	4·64	2·6	2·9	3·6	4·7
„ free	1·64		0·3		1·1	
Silica	0·075		0·291		...	
Water	2·86		0·7		...	

Of soluble salts he found—

	First Type.	Second Type.	Third Type.
Sulphate of lime	1·288	0·053	0·047
Chloride of calcium	0·039	0·233	0·146
Chloride of iron	0·027	0·089	0·114
	1·354	0·375	0·307

But though differing from all other known meteorites, he considers the presence of nickeliferous iron and schreiberite to prove their meteoric origin in spite of the combination of the iron with oxygen, and the abundance of carbon and the large proportion of soluble salts, considering that the preservation of the latter may be due to the feeble tension of the vapour of the northern regions.

Dr. Walter Flight, in his recent article on the History of Meteorites, † quotes Nauckhoff, who analysed ten rocks from Ovifak, and found the basalt to be a compact dark greyish green colour, of felspar (anorthite), penetrating magnetite, augite, and iron, the mass containing 49·18 per cent. of silicic acid. Tschermak describes the augite as of a light green tint, and as filling in spaces between other material, the felspar crystals as transparent, with cavities often filled with some transparent substance, and compares the Ovifak rocks to the meteorites of Juvinas, Petersburg, and Stannern; and Dr. Flight compares them to old augite and anorthite lavas of Java, Iceland, and the Eifel.

The coast of North-west Greenland, Cape York, Wolstenholme Sound, to Cape Hatherton, is described by Dr. Sutherland as composed of trap. From Cape Parry to Bardin Bay the rocks dip S.W., further north-east to the S.W. at 30°. At Whale Sound horizontal beds of sandstone occur, but on the opposite side of Smith's Sound the cliffs are high, rugged, and inaccessible. Between Cape George Russel and Dallas Bay, Dr. Kane ‡ describes the red sandstones as capped by greenstones, weathering into columns, one of which, 480 feet in height, he called Tennyson's Monument, overlooking Sunny Gorge in 79°.

CHARLES E. DE RANCE

(*To be continued.*)

* The position of the plant-bearing localities are marked in Nordenskjöld's Chart, founded on Rink's, Geol. Mag., vol. ix, plate vii., 1872.

† "Zweite deutsche Nordpolarfahrt," No. viii., issued by the Bremen Committee.

‡ Quar. Jour. Geol. Soc., vol. xxviii. 1872; Geol. Mag., vol. ix. p. 461, &c.

* Comptes Rendus de l'Acad. des Sc., t. lxxiv., lxxv.

† Geol. Mag., vol. ii. Dec. 2, p. 154. (London, 1875.)

‡ Arctic Expedition in 1853–55, by E. K. Kane, M.D., U.S.N. (Philadelphia, 1856.)